

**Efficacy of Remote Magnetic Navigation System Coupled with Remote  
Magnetic Technology Open Irrigated Catheter in the Treatment for  
Atrial Fibrillation**

A Senior Honors Thesis

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By

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## **Index**

1. Introduction.....	4
1.1 Heart and its Electrical Conduction System.....	4
1.2 Atrial Fibrillation.....	5
1.3 Epidemiology of Atrial Fibrillation and its Types.....	6
1.4 Causes of Atrial Fibrillation.....	9
1.5 Management of Atrial Fibrillation.....	11
1.6 Stereotaxis Technology.....	13
1.7 Goals of the study.....	15
2. Methods.....	15
3. Results.....	19
4. Discussion.....	25
5. Conclusion.....	27

## **Abstract:**

Introduction: Remote magnetic navigation system is designed to reduce procedure time, complications and fluoroscopy time for ablation of atrial fibrillation. This study reports a single center experience of Remote Magnetic Navigation system for atrial fibrillation radiofrequency ablation using an open irrigated catheter.

Methods: 84 patients with symptomatic atrial fibrillation, who had failed drug treatment, were consequently included in the study. Anti-arrhythmic drugs and anti-coagulation drugs were stopped one prior to the procedure, when possible. All patients were ablated using Remote Magnetic Navigation Odyssey Niobi Stereotaxis system with Remote Magnetic Technology Open Irrigated catheter.

Results: Mean patient age was 60.11 years. Mean EF was 49.64%. The mean procedural and fluoroscopy duration was  $218.17 \pm 37.73$  min and  $28.04 \pm 19.05$  min respectively. The learning curve remained flat throughout the cohort. There were four access site hematomas, one need for intubation, and one CVA with full recovery. The successful elimination of atrial fibrillation at 6 months was 86.36%.

Conclusion: Radiofrequency ablation coupled with Remote Magnetic Navigation system using an irrigated tip catheter is safe and highly acutely effective. Patient radiation exposure is low. Long term follow up is being tracked.

## **1. Introduction:**

### **1.1 Heart and its Electrical Conduction System:**

The heart is a muscular organ that pumps blood through blood vessels to various parts of the body. Heart is made up of cardiac cells which are myogenic. Myogenic muscles contract through the signals from their own cells. The electrical impulses that facilitate contraction of the heart originates at the Sinoatrial (SA) node and continue through the atrial tissues to the atrioventricular (AV) node; at the same time the impulse propagates to the left atrium through the Bachmann's bundle. The impulse is then passed through the bundle of His followed by the Purkinje fibers which stimulate the ventricles to contract and eject blood. The electrical conduction along cardiac muscles follows a similar principle as that of a neuron. Cardiac muscle has a negative potential at rest. In order to conduct electrical impulses it has to be depolarized by an impulse with a threshold potential. During depolarization, the  $\text{Na}^+$  channels on the membranes of the cells are opened. Depolarization is followed by slight repolarization caused by outward flow of  $\text{K}^+$  ions. A plateau stage is reached due to a balance between outward flow of  $\text{K}^+$  ions and inward flow of  $\text{Ca}^{2+}$  ions through L-type calcium channels. This stage is followed by rapid repolarization due to an increase in net outward flow of  $\text{K}^+$  ions and closing of L-type calcium channels.

## 1.2 Atrial Fibrillation

Atrial Fibrillation (AF) is a supraventricular tachyarrhythmia with uncoordinated atrial activation and deteriorating atrial mechanical function. Atrial fibrillation can be diagnosed on an electrocardiogram (ECG) by a replacement of P-waves with rapid oscillatory or fibrillatory waves; varying in shape, period, and amplitude (Fig. 1). The ventricular response to atrial fibrillation depends on the electrophysiological properties of the atrioventricular (AV) node and the conducting tissues, the level of sympathetic and parasympathetic tone, accessory conduction pathways, and drug interactions (3). Atrial fibrillation can occur in isolation or in combination with other types of arrhythmias like atrial flutter or atrial tachycardia. Atrial flutter may also occur during prescribed antiarrhythmic drug treatment for preventing atrial fibrillation. Other types of arrhythmias like focal atrial tachycardias and AV nodal reentrant tachycardias can also trigger atrial fibrillation. This can be indicated by evaluating the P waves on one or more ECG leads (2).

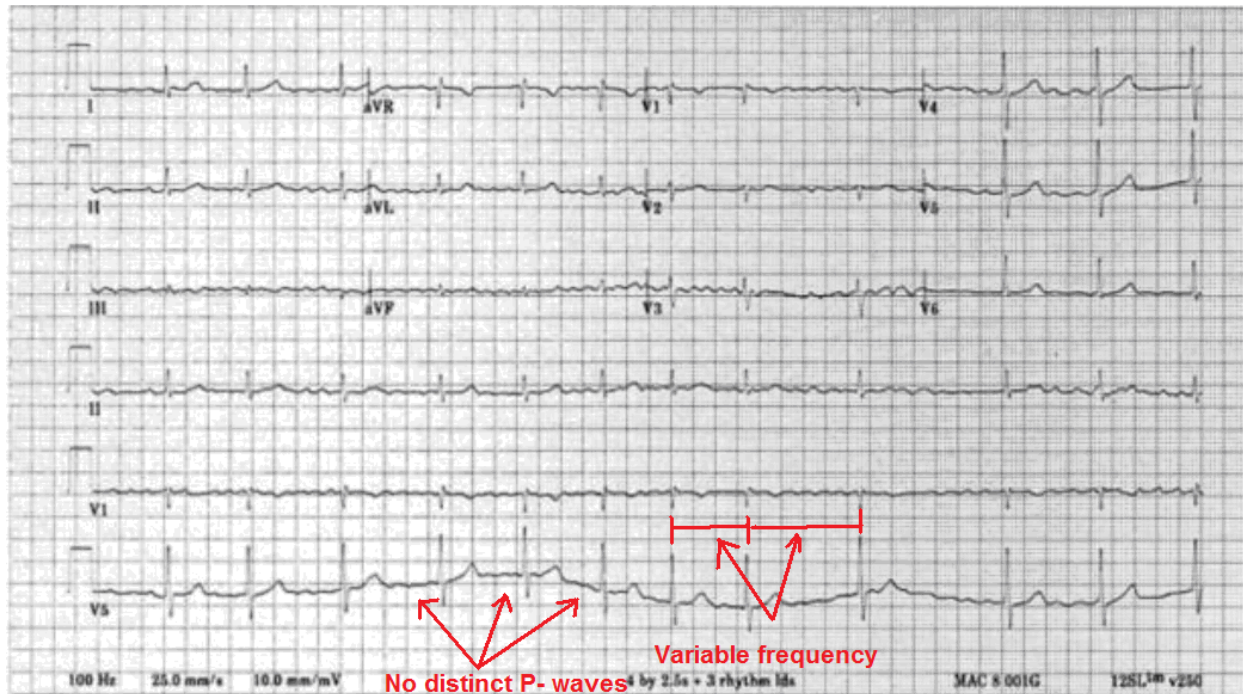


Figure 1: Electrocardiogram showing atrial fibrillation (2).

### 1.3 Epidemiology of Atrial Fibrillation and its types:

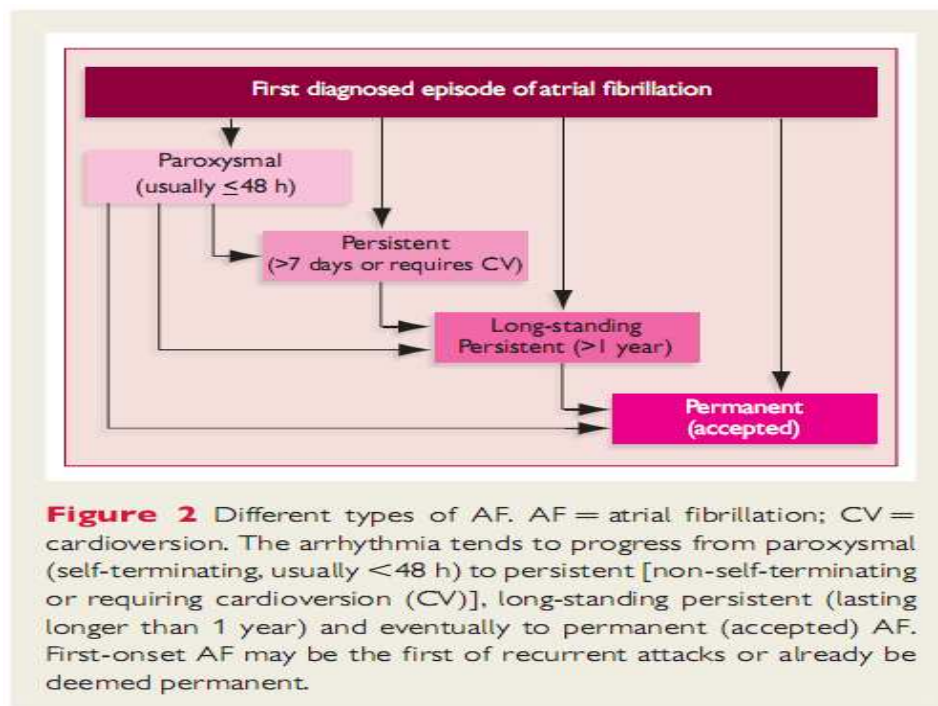
Atrial fibrillation (AF) is the most common type of cardiac arrhythmia. It accounts for about one-third of the hospital admissions relating to cardiac rhythm disturbances.

Although atrial fibrillation is often associated with structural heart disease, a large proportion of patients do not have any heart disease (2). Thromboembolic events and hemodynamic impairment due to atrial fibrillation are causes of significant morbidity, mortality and healthcare cost. The mortality rate in patients with atrial fibrillation is approximately double that of those with sinus rhythm and linked with underlying heart disease (1). It has been estimated that about 6 million Europeans and 2.3 million

Americans suffer from atrial fibrillation and this number is expected to increase to 5.6 million Americans by 2050 (1). In the past 20 years, there has been a 66% increase in atrial fibrillation related hospital admissions, due to factors including aging, a rise in frequency of chronic heart disorders, and improved diagnosis due to ambulatory monitoring devices (4-5). Its prevalence increases with age. Atrial fibrillation is estimated to be prevalent in about 0.4 to 1% of the general population. About 9% of people between ages 80-89 suffer from atrial fibrillation (1). The median age of patients with atrial fibrillation is 75 years. Approximately 70% of the patients are between 65 and 85 years old. The occurrence of atrial fibrillation among men and women is almost equal. Age-adjusted risk of suffering from atrial fibrillation is lower among African Americans than in Caucasian patients (6,7). Atrial fibrillation is an extremely expensive public health problem. The annual per patient costs of treating atrial fibrillation are approximately US \$ 3600. Of these costs 52% are hospital costs, 23% are medications, 9% are consultations, 8% are further investigations, 6% loss of work and 2% are paramedical procedures. The societal burden is approximately US \$ 15.7 billion in the European Union (2).

Atrial fibrillation can be categorized into different types based on the number and duration of the episodes. Many systems have been proposed including the ECG and endocavitary monitoring of atrial electrical activity, but none of them fully account for all cases of atrial fibrillation. The categories of atrial fibrillation are not mutually exclusive and can change over time; hence it is important to categorize atrial fibrillation at a given moment. One of the most accepted classification systems is based on simplicity and clinical relevance. When a clinician first diagnoses atrial fibrillation, it is considered as

first detected atrial fibrillation. These atrial fibrillation can be paroxysmal or persistent. Two or more atrial fibrillation episodes that self-terminate within seven days are considered paroxysmal; when sustained beyond seven days, atrial fibrillation is classified as persistent. Persistent atrial fibrillation that are sustained for more than one year are considered long-standing persistent. This type of atrial fibrillation usually leads to permanent atrial fibrillation (2).



(8)

Figure 2: Classification of atrial fibrillation

Another type of atrial fibrillation wherein atrial fibrillation is not a primary condition is called 'Secondary AF.' In this case, atrial fibrillation occurs in a setting of myocardial infarction, cardiac surgery, hyperthyroidism, or pulmonary embolism. Curing of the underlying disorder terminates atrial fibrillation (2). Atrial fibrillation in individuals



younger than sixty years without any underlying cardiopulmonary disorders is categorized as 'Lone AF' (9). According to the Euro Heart Survey on atrial fibrillation, lone AF accounts for 10% of atrial fibrillation patients, 15% of paroxysmal, 14% of first detected atrial fibrillation, 10% of persistent, and 4% of permanent atrial fibrillation (10).

#### **1.4 Causes of Atrial Fibrillation**

In many cases, the cause of atrial fibrillation is unknown, as it is difficult to distinguish the causes of atrial fibrillation and the consequence of suffering from atrial fibrillation. However, the most frequent pathoanatomical changes related to atrial fibrillation are atrial fibrosis and loss of atrial muscle mass (2). Histological studies of atrial tissues of atrial fibrillation patients indicated patchy fibrosis arranged juxtaposed to normal atrial fibers, which may be responsible for non-homogeneous electrical conduction (11). Biopsy studies of the posterior wall of the left atria (LA) indicated mild to moderate fibrosis in patients with sinus rhythm or atrial fibrillation for shorter duration; while severe fibrosis was observed in long-standing persistent atrial fibrillation patients (12). According to atrial tissue specimens from patients with dilated cardiomyopathy, the extracellular matrix is associated with sustained atrial fibrillation, wherein the atrial insulin-like growth factor II mRNA-binding protein 2 (IMP-2) is down-regulated; along with up-regulation of metalloproteinase 2 (MMP-2) and 1 collagen volume fraction (CVF-1) (13). Furthermore, atrial biopsies from patients revealed apoptosis that led to the replacement of atrial myocytes with interstitial fibrosis, accumulation of glycogen granules extra-cellularly, and disruption of gap junctions between cells. In patients with

long-standing persistent atrial fibrillation, membrane-bound glycoproteins that maintain cell-cell and cell-matrix interactions have doubled (14-15). Atrial fibrosis is also believed to be caused by a mutation in an AC gene like lamin (16). Fibrosis can also trigger atrial dilation. Atrial stretch activates many molecular pathways, like the renin-angiotensin aldosterone system (RAAS). Stretch leads to up-regulation of angiotensin II and transforming growth factor beta 1 (TGF beta 1), which induces the production of connective tissue growth factor (CTGF) (17). Patients with persistent atrial fibrillation demonstrated increased amounts of extracellular signal-regulated kinase messenger RNA (ERK-2-mRNA) and a 3-fold increase in the expression of angiotensin converting enzyme (ACE) (18). Experimental and clinical studies have demonstrated that atrial fibrillation incidence can be reduced by using ACE inhibitors that reduce fibrosis, frequency of atrial premature beats, and also lower the relapse time post-cardioversion (2). Drug therapy involving ACE inhibitors and antiarrhythmic agents enhance maintenance of sinus rhythm (20). Drug combination of amiodarone (antiarrhythmic drug) and enalapril or irbesartan (ACE inhibitors) lowered the rate of recurrent atrial fibrillation in patients with persistent atrial fibrillation and normal left ventricular function after electrical cardioversion; as compared to those with amiodarone alone (21, 22).

The risk of stroke increases in patients with atrial fibrillation. In atrial fibrillation, the atria fibrillates, leading to inefficient pumping of blood into the ventricles. This leads the stagnant blood in the atria to clot, which can get into the blood stream and cause strokes. About 36% of the strokes in 80 to 89 year old patients are caused by atrial fibrillation. Clinically, thrombus formation occurs in patients in atrial fibrillation for

approximately 48 hours. Hence, anticoagulation is recommended in patients with atrial fibrillation lasting more than 48 hours (2).

### **1.5 Management of Atrial Fibrillation**

Patients with atrial fibrillation are managed based on two objectives: prevention of prolonged tachycardia and prevention of thromboembolism. Prolonged tachycardia can be prevented by two strategies: rate control and rhythm control. Under rate control management, the ventricular rate is controlled without focusing on maintaining normal sinus rhythm. While under rhythm control management, effort is made to restore or maintain normal sinus rhythm, while also attempting to control the rate. In either case attention is focused on preventing thromboembolism using anticoagulation therapy (2). At the initial encounter with the patient, overall management strategy should be discussed concerning several factors like: type and duration of atrial fibrillation, severity and types of symptoms, associated cardiovascular disease, patient's age, associated medical conditions, long-term and short-term treatment goals, and pharmacological and non-pharmacological therapeutic options (2).

In treating patient for atrial fibrillation, rhythm control drugs are the first choice and left atrium ablation is the second. Ablation of AV node and implanting a permanent pacemaker is the final option. In some patients, especially the young, atrial fibrillation ablation is the first choice thereby avoiding many years of drug therapy. Some patients are cardioverted to bring them back into normal sinus rhythm. Cardioversion can be performed electrically or with therapeutic drugs. Cardioversion carries a risk of thromboembolic events, hence anticoagulation therapy is initiated before the procedure

in patients with arrhythmia for more than 48 hours. Drugs are commonly used as the first line of treatment in spite of their risk of drug-induced torsades de pointes (a type of ventricular tachycardia) or other arrhythmias. Moreover, direct current cardioversion is more effective than pharmacological cardioversion. The disadvantages of electrical cardioversion is its need for anesthesia or conscious sedation (2). Pharmacological cardioversion is most effective when initiated within 7 days of the onset of atrial fibrillation episodes. A significant number of patients realize spontaneous cardioversion within 24-48 hours (2). Some therapeutic agents have proven efficacy for performing cardioversion in patients with atrial fibrillation. Amiodarone may be given orally or intravenously. "In a meta-analysis of 18 trials, the efficacy of amiodarone ranged from 34% to 69% with bolus (3 to 7 mg/kg body weight) regimens and 55% to 95% when bolus was followed by a continuous infusion (900 to 300 mg daily)" (2). In SAFE-T trial involving 665 persistent atrial fibrillation patients, 27% patients underwent cardioversion with amiodarone after 28 days of treatment compared to 24% with sotalol and 0.8% with placebo (23). Amiodarone had many side effects like bradycardia, thyroid abnormalities, visual disturbances, nausea and hypotension (2). Although sotalol has proven efficacy for maintaining sinus rhythm, there is no established efficacy for pharmacological cardioversion in persistent atrial fibrillation patients (2).

Doefetilide and ibutilide are drugs that are more efficient at cardioversion of atrial flutter than atrial fibrillation (2). In 7 studies, the success of flecainide single loading dose (300 mg) led to cardioversion of atrial fibrillation ranging from 57% to 68% at 2-4 hours and 75% to 91% at 8 hour period after drug administration (24).

Pharmacologically, propafenone is more effective for cardioversion of atrial fibrillation

between 2 and 6 hours after oral administration (25). Non-pharmacological cardioversion can be performed using direct-current cardioversion. Direct-current cardioversion is done by delivering electrical shock synchronized with sensing R wave on the ECG. The electrical shock can be applied through the external chest walls or through an internal cardiac electrode. The current density depends on defibrillator voltage, output waveform, size and position of the electrode paddles and thoracic impedance (2). Non-pharmacological treatment is usually employed when the antiarrhythmic drugs are ineffective. Another option for surgically treating atrial fibrillation is by performing surgical ablation that ensures transmural lesions to isolate pulmonary veins and connect these dividing lines to the mitral valve annulus, and thereby creating electrical barriers in the right atrium that prevent sustaining macroentrant rhythms (26). Surgical ablation procedure is not widely recommended because they can only be performed if the patient undergoes cardiopulmonary bypass surgery. Another more recommended option is minimally invasive catheter ablation, wherein tissues causing irregular rhythms are isolated and ablated using radiofrequency, laser, ultrasound, or cryo. Research has shown abnormal action potentials may develop at various positions in the left and right atrium, pulmonary veins, left atrium posterior wall, superior vena cava, vein of Marshall, crista terminalis, interatrial septum, and coronary sinus (27).

### **1.6 Stereotaxis Technology and Open Irrigated Catheter:**

Stereotaxis is a remote magnetic technology that can steer and manipulate a venous catheter without an electrophysiologist controlling it manually. In this technology, the

catheter is guided proximally at the catheter's tip using the magnetic field produced by the use of two powerful magnets. This helps in making sure the ablation tip is held in accurate position while performing radiofrequency ablation. This technology has also helped in significantly reducing the amount of fluoroscopy exposure time for the physician and the patient undergoing the procedure and also reducing the risks of procedural complications.

Remote Magnetic Technology Open Irrigated catheter was used in these procedures. This catheter helps in improving the ability to form successful lesions. The constantly-flowing saline maintains the tip at tissue temperature, which avoids clotting of blood surrounding it called charring. It also provides the physician with flexibility and better maneuverability.



Figure 3: Niobi Odyssey Stereotaxis Remote Magnetic Navigation System (29)

### **1.7 Goals of the Study:**

The main goal of this study is to evaluate this new remote magnetic navigation technology in the treatment of atrial fibrillation. This new technology is expected to significantly reduce the fluoroscopy time for both doctors and patients; reduce the procedural complication rate and also improve the procedural success rate. A significant amount of patients have to undergo more than one ablation procedure for their atrial fibrillation. The increase in success rate with this technology can reduce the chances of undergoing a repeat procedure, thereby reducing the societal economic burden.

### **2. Methods:**

Radiofrequency ablation was performed on all participating atrial fibrillation patients, using the Niobi Odyssey Stereotaxis system (Remote Magnetic Navigation System), coupled with a Remote Magnetic Technology (RMT) Cool Open Irrigation ThermoCool catheter. All Patients were consecutively included if they were symptomatic and failed medical therapy. All antiarrhythmic drugs and oral anticoagulation were stopped three days prior to the procedure. Amiodarone was stopped one month prior to RFA when possible. Four types of catheter were used during the procedure: an ultrasound catheter, a lasso mapping catheter, an ablation RMT, and a coronary sinus catheter. Among those, the lasso catheter and the ablation catheter go transeptal from right atrium to the left. These catheters were inserted, through sheaths, to the right atrium

through the inferior vena cava and right or left femoral vein. A small aperture is made through the septum to allow the lasso and ablation catheter to pass to the left atrium. The Lasso catheter with its densely placed electrodes, was used to isolate pulmonary veins and ablation catheter was accordingly used to ablate the tissues.



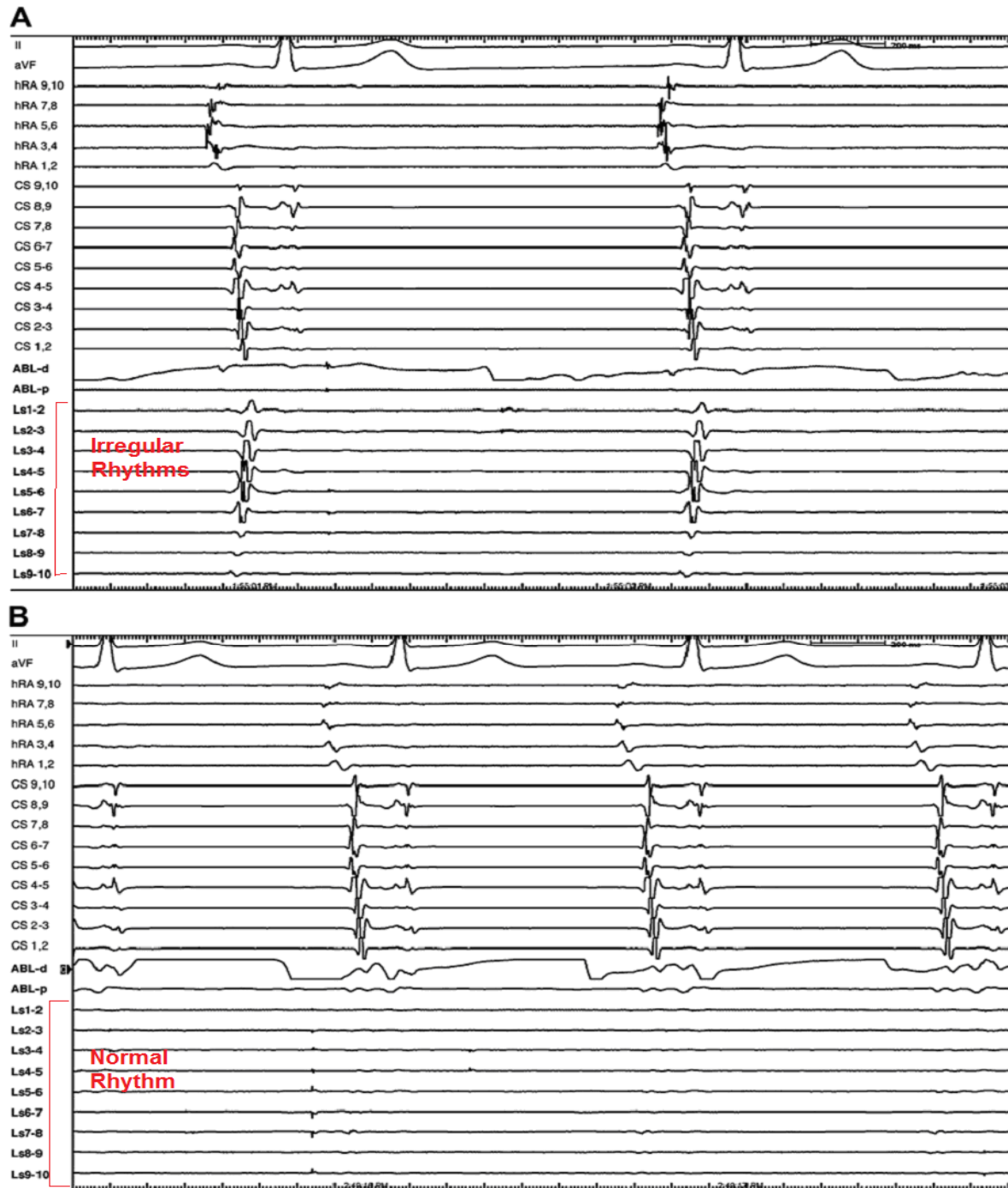


Fig. 2. Intracardiac electrograms demonstrating potentials within the right inferior pulmonary vein pre-isolation (A) and absence of potentials on the mapping ring catheter (LS 1–10) post isolation (B). (28)

Figure 4: Intracardiac electrograms demonstrating potentials before (A) and after (B) pulmonary vein isolation.

Care was taken that the activated clotting time (ACT) range was 300-350 sec. to prevent thromboembolic events. During the procedure, the electroanatomical mapping 'Carto' System was used for guiding catheters. Fluoroscopy was used to make sure the movement of the catheter did not cause any cardiac perforations.

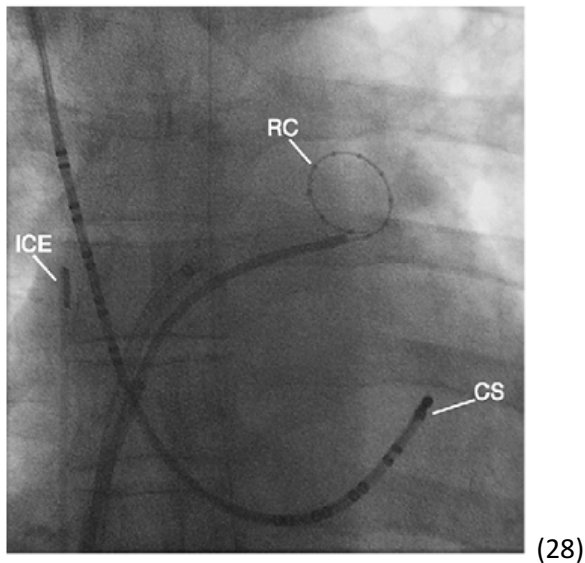


Figure 5: Fluoroscopy used during the procedure

Maximal power delivered was 35 watts. Patients with Paroxysmal atrial fibrillation (PAF) were treated with circumferential ablation around the pulmonary veins (PVs). A roof line was added to the circular lesions for patient with persistent atrial fibrillation and in patients with longstanding persistent (LSP) fractionated potentials were also targeted. Acute success was measured by PV entrance block and/or non-inducibility with 20 mcg/min of isoproterenol. The use of manual catheters was left to the discretion of the physician performing the procedure. Patients were asked to return to the clinics after 3 months, 6 months and 1 year after their procedure for follow-ups. In order to monitor their heart rhythm and any recurrence of arrhythmia, the patients were monitored for 7

or 30 days with an event-monitoring system that monitors their heart rate and rhythm; thereby aiding the physician in judging the clinical outcome of the procedure. Patients with implanted pacemakers were not required to have an event-monitoring system. All the procedural information was written down on a form present in the electrophysiological labs at The Ohio State University Medical Center by the nurses and attending electrophysiologists. This information was verified and extracted with the use of electronic medical records system 'e-results.' These data were maintained and analyzed using Microsoft Excel. The database contains information for procedures performed after February of 2009. The learning curve for the physicians was analyzed using all the procedures used in the study. The fluoroscopy time was compared for both manual and stereotaxis performed procedures. Only the first seven procedures, performed during the same time frame, with manual and stereotaxis approach, were used for the analysis for both the electrophysiologists. The clinical success rate for patients was calculated based on their atrial fibrillation condition after a minimum of six months post procedure. The student T-tests were performed, using two-tailed unpaired conditions, on the mean fluoroscopy time data analysis.

### **3. Results:**

In this study, 84 patients underwent atrial fibrillation procedure using stereotaxis, remote magnetic navigation system and remote magnetic technology catheter. The average age of the patients were 60.11 years with a standard deviation of 9.40, with ejection fraction rate being  $49.64 \pm 11.63\%$ . Among these patients, 45.24% patients presented

with paroxysmal atrial fibrillation, 44.05% with persistent atrial fibrillation, while 10.71% with long-standing persistent atrial fibrillation.

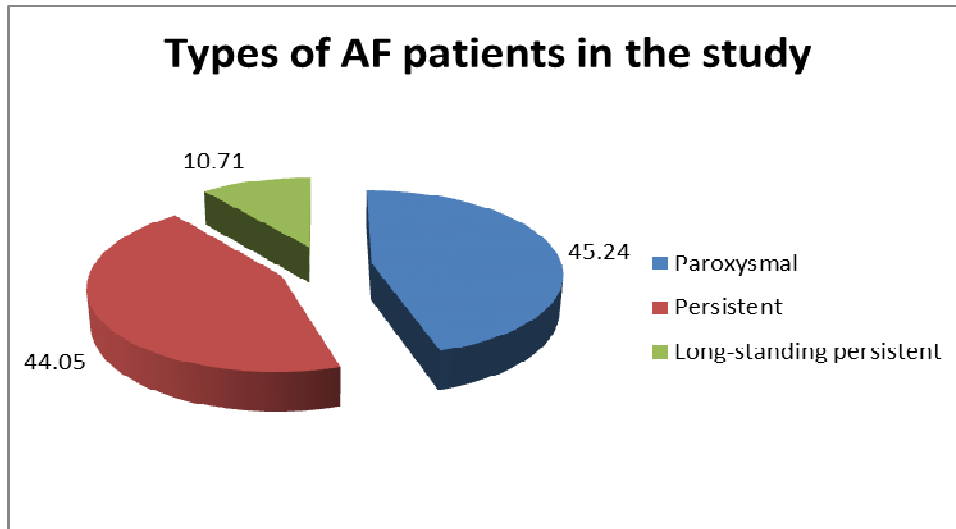


Figure 6: Types of atrial fibrillation in patients.

It has been observed that the amount of fluoroscopy time used by the stereotaxis system is lower than in traditional manual method. Fluoroscopy is a type of medical imaging technique that uses X-ray radiation. During an atrial fibrillation ablation procedure, an electrophysiologist usually uses fluoroscopy to make sure no perforations were caused while pulling or pushing the catheter. The amount of fluoroscopy used during the stereotaxis procedure was  $28.04 \pm 19.05$  minutes, as compared with  $56.17 \pm 36.96$  minutes using the traditional approach. The difference between the fluoroscopy times using the two methods is significant ( $p < 0.005$ ). To be more specific, the mean fluoroscopy used during the procedures for going transeptal was  $5.68 \pm 4.10$  minutes, for mapping it was  $3.76 \pm 5.22$ , and for radiofrequency ablation it was  $8.69 \pm 10.10$  minutes. The stereotaxis is a new technology and requires training. Hence,

an associated learning curve can be experienced by the physicians. Drs. A and B are actual physicians who performed these procedures. Their identity has been disclosed due to confidentiality reasons. Dr. A have performed procedures on 54 of these 84 patients; while Dr. B have performed procedures on 28 out of the remaining patients. Among those only 9 procedures were performed using a complete stereotaxis approach. During the remaining 19 procedures Dr. B switched from stereotaxis to manual approach, sometime during the procedures.

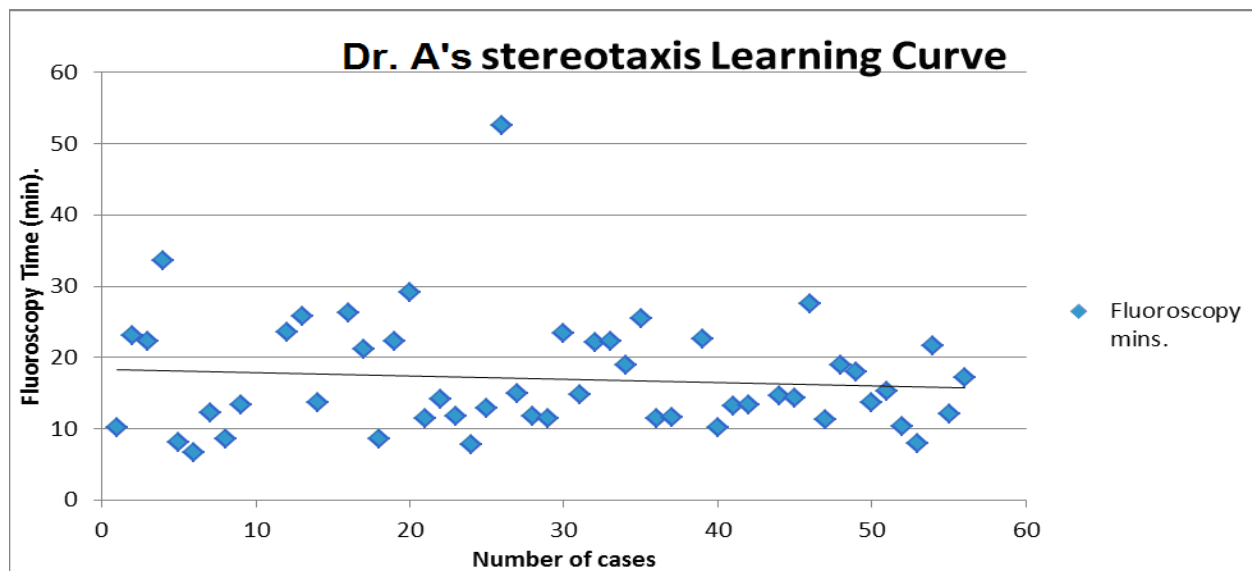


Figure 7: Dr. A's stereotaxis learning curve

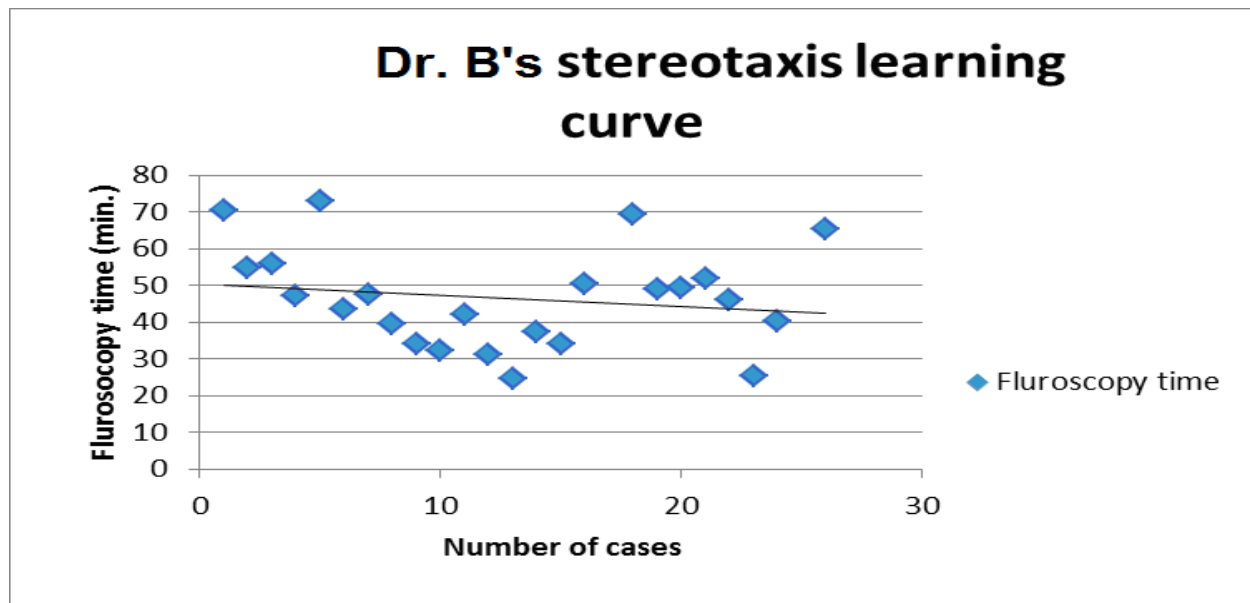


Figure 8: Dr. B's stereotaxis learning curve

The difference in fluoroscopy used by Dr. A while using stereotaxis and traditional was quite significant. The mean fluoroscopy time of the 7 procedures performed manually was  $33.29 \pm 16.14$  minutes; while that of the 7 procedures performed through stereotaxis was  $16.59 \pm 9.92$  minutes (fig. 9).

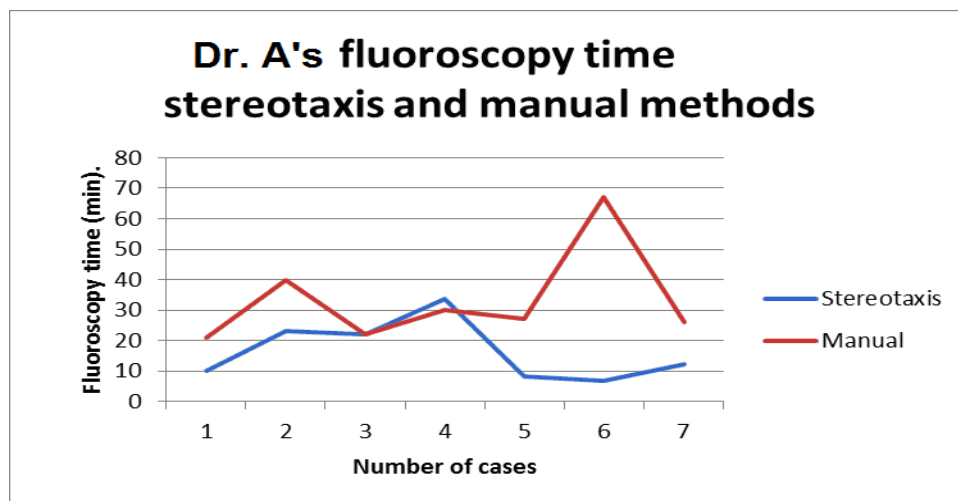


Figure 9: Dr. A's fluoroscopy time comparison

Similarly, the mean fluoroscopy time for Dr. B's 7 procedures performed using manual method is  $74.57 \pm 36.32$  minutes; while that with stereotaxis was  $56.01 \pm 11.62$  minutes (fig. 10).

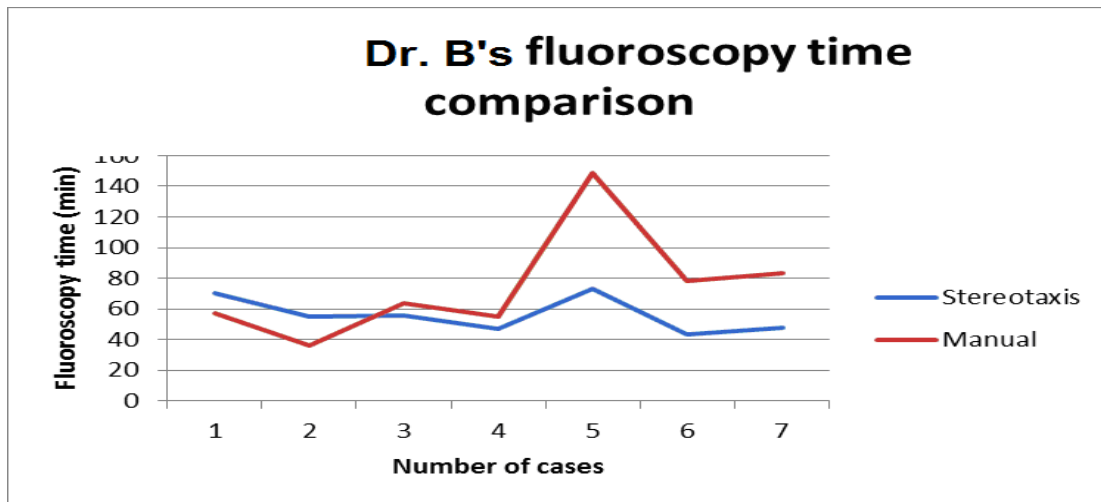


Figure 10: Dr. B's fluoroscopy time comparison

Because atrial fibrillation is not always completely cured by only one radiofrequency ablation procedure, many patients have to undergo the procedure multiple times. In this study of 84 patients, 15 patients have previously undergone one atrial fibrillation ablation procedure; among these 15 one of them was treated with stereotaxis method, while the remaining fourteen were treated through the manual method. Moreover, seven patients have undergone a second procedure following the procedure studied in this project; among which four of them were treated through the stereotaxis method, while the remaining three were treated through the manual method. One patient had undergone two atrial fibrillation ablation procedures prior to the studied procedure, the second procedure being through the stereotaxis method and the first through manual method. After the procedure was performed, the patient's rhythm was monitored using

a 30 days or a 7 days event-monitoring system. Patients may participate in this monitoring system multiple times at planned intervals. The report generated by this system helps a physician evaluate the patient's rhythm during his/her day-to-day activity outside of the hospital. The following data are based on the patient's latest event-monitoring report during the study:

<b>Duration of atrial fibrillation</b>	<b>Number of patients</b>
<b>Normal Sinus Rhythm (NSR)</b>	37
<b>AF &lt; 1 hour</b>	1
<b>AF &lt; 12 hours</b>	2
<b>AF &lt; 1 day</b>	2
<b>AF &lt; 1 week</b>	8
<b>AF &gt; 1 week to 1 month</b>	3
<b>AF is present, but duration is unknown</b>	5

Table 1: Analysis of Event Monitoring Report System for patients

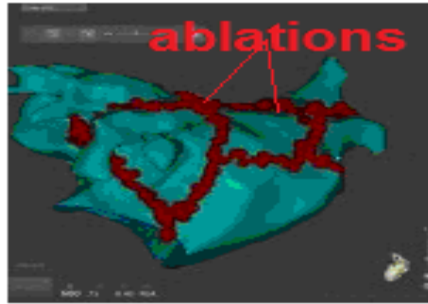
Out of 84 patients, only 44 patients had a follow up of six months of more post procedure. The clinical success rate from the use of the new stereotaxis technological approach was observed to be 86.36%. The mean procedural time was  $218.17 \pm 37.73$  minutes. Complications do occur during the atrial fibrillation ablation procedure. During this study, four patients suffered from post-procedural groin hematoma, one with



intubation due to anesthesia and one from phrenic nerve paralysis. One procedure was aborted due to an occurrence of a stroke during the procedure.

#### **4. Discussion:**

Atrial fibrillation radiofrequency ablation using stereotaxis not only significantly reduces the amount of fluoroscopy exposure to the patients, but also for the electrophysiologists. It has been estimated that the use of remote magnetic navigation system reduces the physician's lifetime exposure to radiation by about 90%, which is equivalent to about 776 chest X-rays (29). At the same time, the use of stereotaxis also reduces disabling back injuries to the electrophysiologists. About 52.7% of interventional cardiologists are being treated for back and neck pain and about 21.3% of them missed work due to back problems (29). Stereotaxis approach reduces the amount of time a physician has to stay next to the patient's bed side. This not only reduces the exposure to fluoroscopy, but also alleviates the need for wearing heavy lead suit. Stereotaxis uses an electroanatomical carto mapping system, which provides the attending electrophysiologists with a 3D electroanatomical map of the heart. This prevents the attending physician from having to use excessive fluoroscopy to track the catheter. The stereotaxis system consists of two rear-earth magnets, which generates an artificial north and south pole creating approximately 18 cm. of electromagnetic sphere, wherein a catheter can move precisely. This magnetic force is not powerful to create perforations, which usually account to 2-5% of manual procedural complications.



(30)

Figure 11: Carto Image

Excessive radiation of any kind can lead to cancer, cataracts and many other associated disorders. Furthermore, the stereotaxis system is coupled with a remote magnetic technology open irrigated catheter, which is very effective in ablating tissues. The catheter also has a soft ablation tip that alleviates the chances of complications during the procedure and makes more effective contact with the tissues during the heart's rhythmic motion.

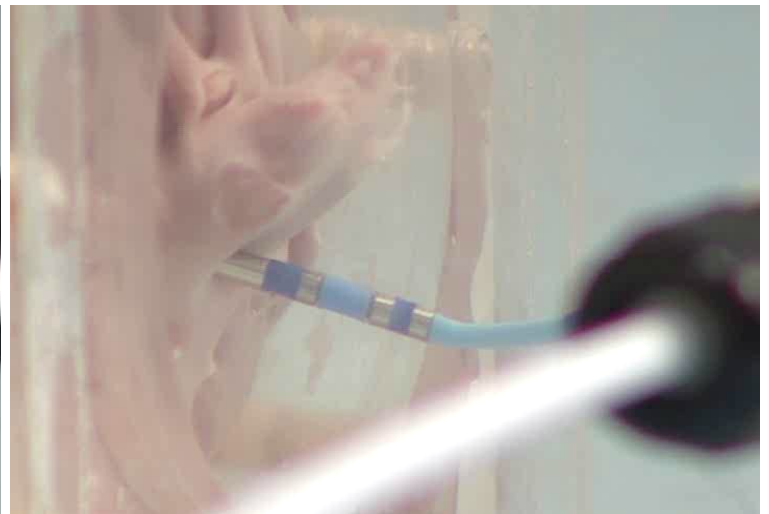


Figure 12: RMT catheter (on right)

non-RMT catheter (on left) (29).

## **5. Conclusions:**

Radiofrequency atrial fibrillation ablation coupled with stereotaxis remote magnetic navigation system is safe and highly effective. Patient radiation exposure and complications are low. There is still a wide variation in procedural duration. Long term follow up is being tracked.

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